A Scalable Water Balance Model Within the Russian River, California, Basin

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The Russian River watershed is facing water resource challenges from farming, urbanization, gravel extraction, forestry, and fish habitat restoration. Possible changes in annual discharge are examined from extensive records of historical flow and precipitation data.
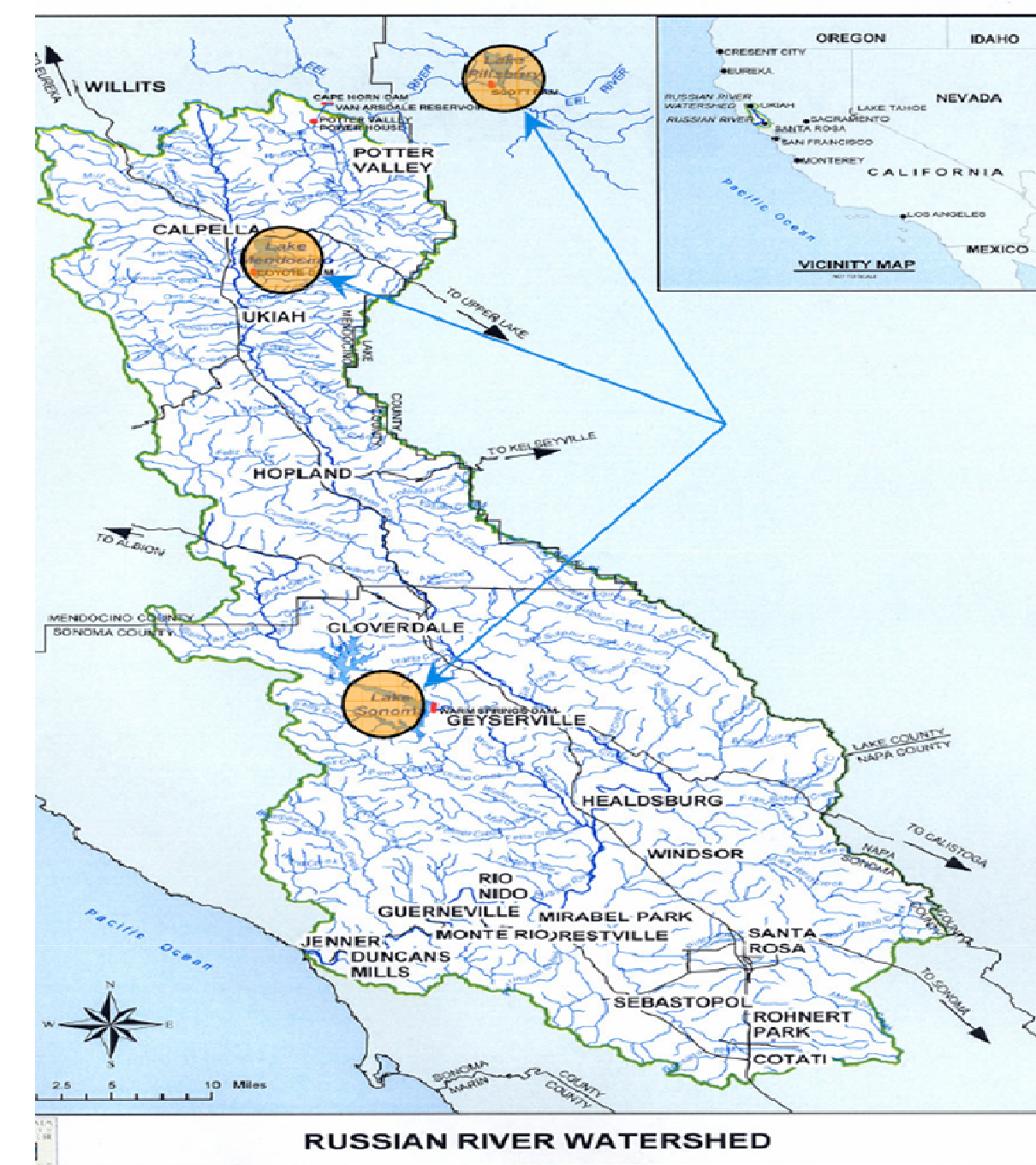
Annual water balance model states

$dS/dt = P - R - ET$

For $\Delta t = 1$ water year, and $\Delta S \approx 0$, therefore $R = P - ET$ is expected for climates with long-dry periods where there is little net change in storage.
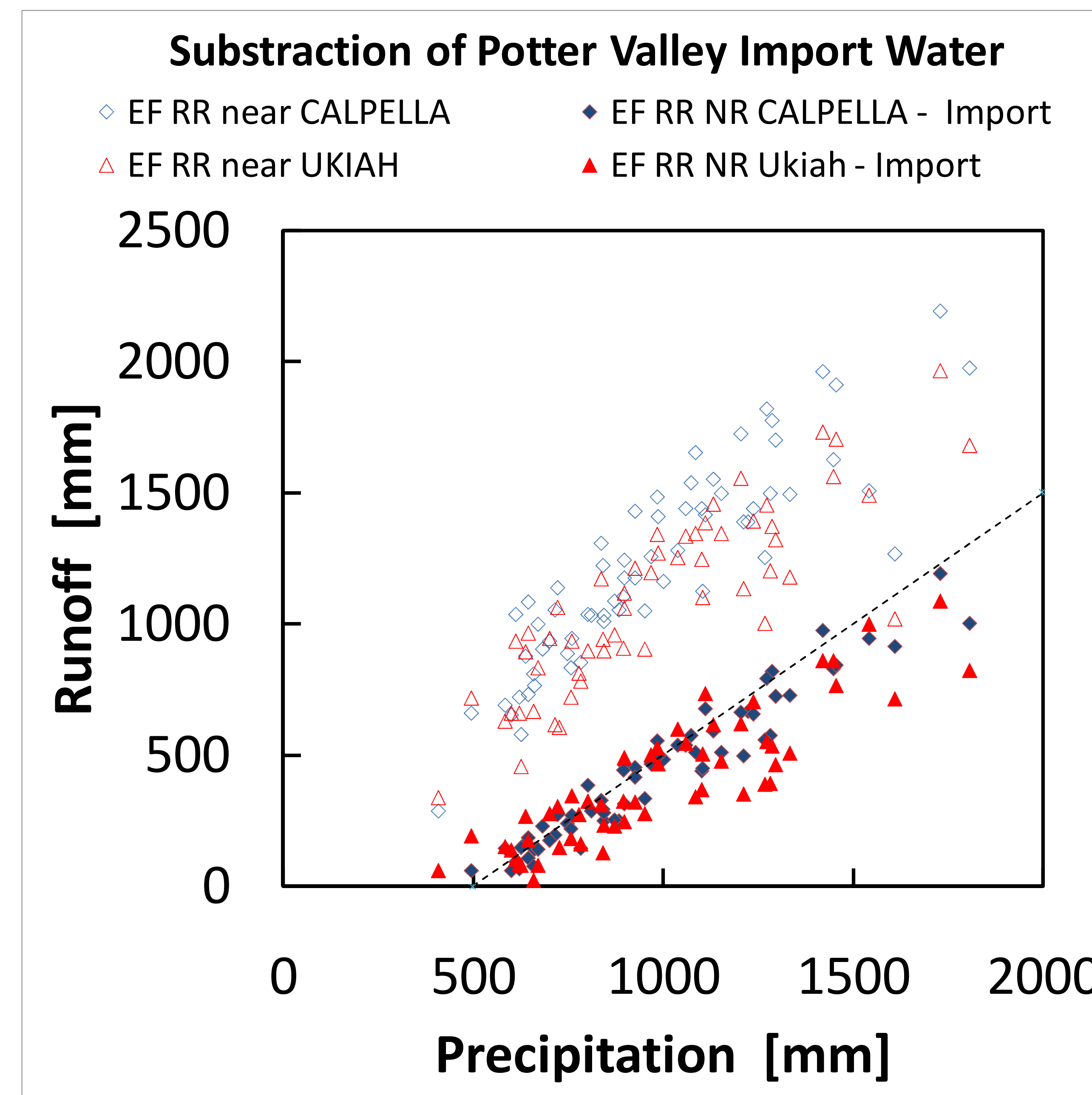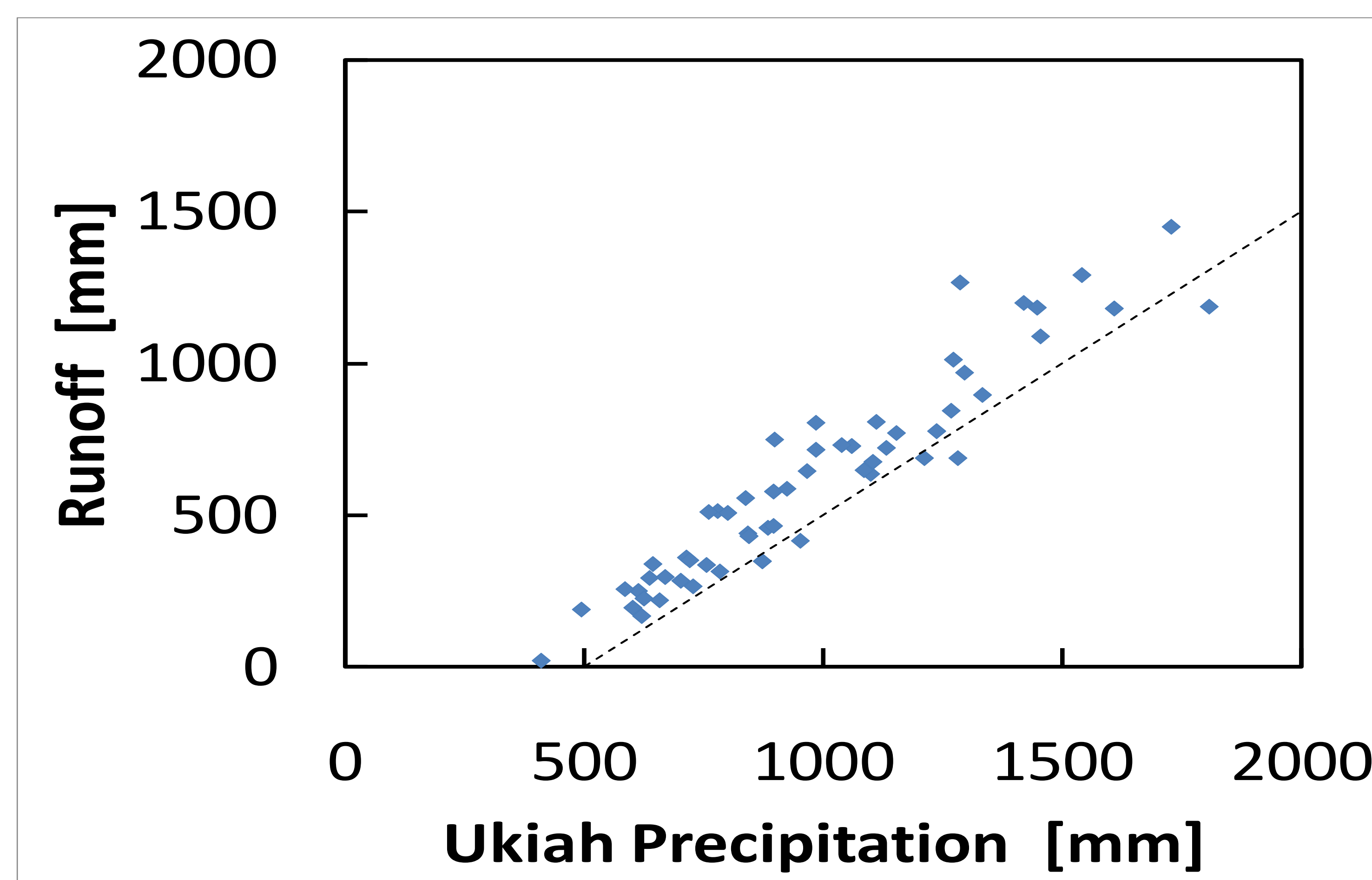

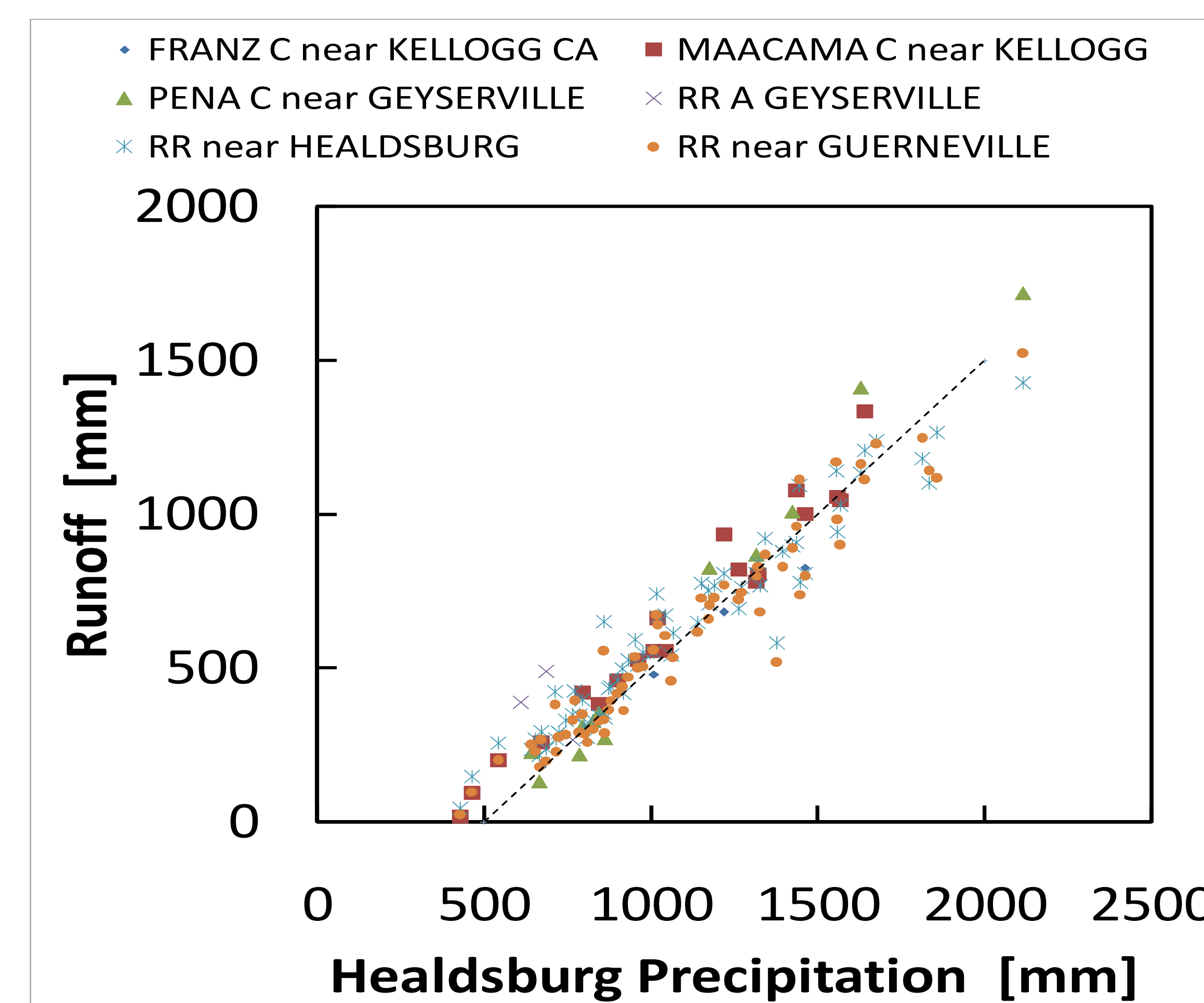Data Sources:
US Geological Survey Stream Gauges
NOAA precipitation data
Data loaded into Datacube for ease of access.

An example plot is shown below for the annual runoff at the USGS gauge on the Russian River near Ukiah (259 km^2) plotted against Ukiah precipitation over the period 1953 to 2006. Dashed line is $R = P - ET$.

Substraction of Potter Valley Import Water

◇ EF RR near CALPELLA   ◆ EF RR NR CALPELLA - Import
△ EF RR near UKIAH   ▲ EF RR NR Ukiah - Import

Within the main stem of Russian River, six watersheds ranging in area from 41 km^2 (Franz Creek) to 3500 km^2 (Russian River near Guernville) all have a similar relationship represented by dashed line: $R = P - ET$

• FRANZ C near KELLOGG CA   ■ MAACAMA C near KELLOGG
▲ PENA C near GEYSERVILLE   ✕ RR A GEYSERVILLE
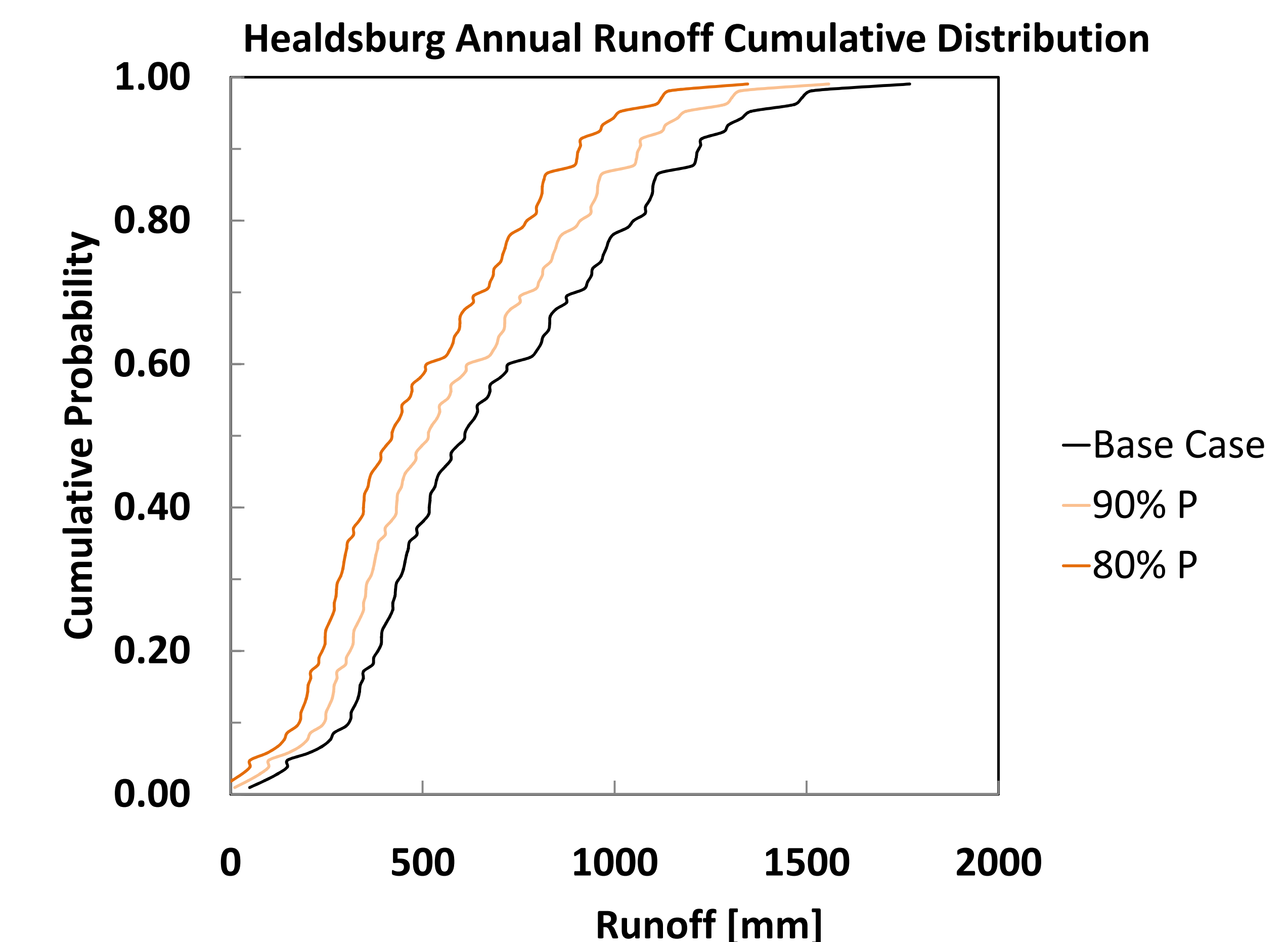✳ RR near HEALDSBURG   ● RR near GUERNEVILLE

Simple annual water balance model is easily fit to watersheds with 100-fold variation in area, using a single parameter, ET, that varies little within the Russian River basin.

What could determines the magnitude of intercept "ET"?
1. Ecosystem determines ET by soils and climate, or
2. Value of ET appears to coincide with lowest recorded annual rainfall which determines vegetation.

Additional basins are under analysis to determine the scalability of this observation.

This model of basin hydrology permits exploration of how a 10% and 20% decrease in annual precipitation alters runoff distribution, assuming ET stays constant: